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A COMPARATIVE STUDY ON THE PHYTOPLANKTON OF THE SHATT AL-ARAB ESTUARY UP AND DOWNSTREAM BASRAH CITY CENTRE, IRAQ

Abdullah H. AL- Mousawi, Hussain A. AL- Saadi & Rafi A. Hadi*
Department of Biology, College of Science, University of Basrah, Basrah, Iraq.

The phytoplankton are the major primary producers in many aquatic environments especially the estuaries. The Shatt al-Arab estuary is the only source of water supply to the city of Basrah of about one million inhabitants. It receives the untreated sewage of the city by many canals. Several studies have been made on the composition, distribution and ecology of phytoplankton in the Shatt al-Arab (Kell & Saad. 1975; Saad & Kell, 1975; Huq et al. 1978; Al-saadi et al. 1979 and 1981; Schiewer et al 1982; Hameed et al. 1982, Hadi et al. 1984). Few studies were also made on the limnology, primary productivity, phytoplankton composition and pollution status in some of the major sewage- discharging canal of Basrah city (Sarker et al. 1980; Al-Issa 1981; Al- Saadi and Antoine 1981; Antoine and Al-Saadi 1982, Antoine 1983). The effect of sewage input of Basrah city on the phytoplankton of the Shatt al- Arab has received little attention. The present study was planned to show the effect of the sewage input of Basrah city centre on

* Present address: Department of Biology, College of Education for Women, University of Baghdad, Iraq.

phytoplankton composition of the Shatt al- Arab estuary. Enrichement of water samples of the Shatt al- Arab with the major nutrients and its effect on the phytoplankton composition was also included as a preliminary attempts on the assesment of the factors likely to be limiting the growth of phytoplankton in the estuary.

Materials and Methods

The study area

The Shatt al- Arab is the most important source of water in the arid surroundings of southern Iraq. Several hundreds canal empty into the Shatt al- Arab from its origin at Garmat Ali upstream of Basrah city to its end in the Arab Gulf. Most of the domestic sewage and industrial effluents are disposed into the estuary by four highly polluted canals namely Al- Rabat, Al-Khandak, AL- Ashar and Al- Khora (Fig. 1). Two stations were selected up and downstream of Basrah city centre. Station I was located about 2Km upstream of city centre and station II was located about 2Km downstream of the city centre. The distance between the two stations is about 5Km. The water level in the Shatt al- Arab is affected by a semi- diurnal tides of the Arab Gulf with an average range of about 1.7m. The mean current velocity is about 0.8ms^{-1} and the water discharge range between 300- 2500 ms^{-1} during low flood period (september to December) and between 2600- 6000 ms^{-1} during high flood period (March to May) (Al- Saadi and Antoine 1981).

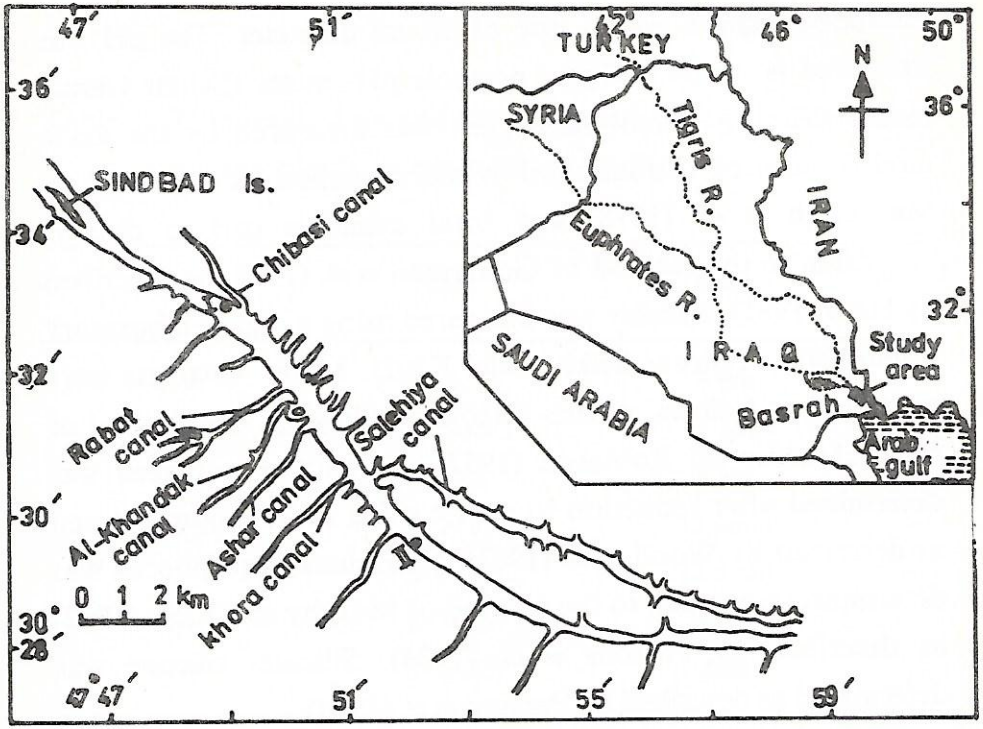

Fig 1, The study area showing the selected stations, I upstream and II downstream Basrah City Centre, Iraq.

Air and water temperatures were measured in situ using a thermometer accurate to the nearst 0. 1°C. Light penetration was estimated using a Secchi disc of 30 cm diameter. The pH was measured in situ by a digital portable pH- meter (Schatt Gerate model CG817). Dissolved oxygen was measured by the azide modification of the standard Winkler method as described by Mackereth et al. (1978) and total available carbon dioxide according to the method of Golterman et al. (1978) as described by Hadi (1981). Salinity was measured using a digital laboratory salinometer (Tsuruni Seiki model E202). Major nutrients were measured as follows, nitrite- nitrogen following the method of Bendschneider ad Robinson (1952) and nitrate- nitrogen was determined after reduction to nitrite using a cademium column as described by Wood et al. (1967). Phosphate- phosphorus was determined according to the method of Murphy and Riely (1962) as described by Parsons et al. (1984). Silicate- silicone was determined as described by Parsons et al. (1984).

Water Samples used for the study of phytoplankton were collected from both stations. Seven wates samples were collected from each station at selected levels of tide (Table 1). Phyto-plankton counting and identification were made as described by Hadi (1981). Entrichment of water samples with the major nutrients was made. The nutrients studied were PO_4- P, NO_3-N and SiO_3-Si; which were added at a rate of 5,50 and 200 umol l^{-1}, respectively. Water samples were taken into Erlenmyer flasks (ca 3 litres). After enrichment; flasks were placed in an illuminated cabinet (6000 lux) at 20 ± 2^0 C. They were shaken and randomized three times a day. Experiment was terminated five days from inoculation. At the end of the experiment;

Table 1: Tide level, date and time selected for the collection of water samples from the stations studied.

tide level	date	time
Low	28- 2- 85	4 pm
high	2- 3-85	8 am
	3-3-85	8 am
Initial low	2- 3- 85	12 noon
	3- 3- 85	12 noon
low	2- 3- 85	4 pm
	3- 3- 85	4pm

phytoplankton counting and identification were made as described previously.

Results and discussion

Ecological conditions

The results of the ecological conditions of the Shatt al-Arab estuary in the two stations studied are shown in Table 2. The results are within the range of the previous studies (Hameed 1977, Al- Saadi et al. 1976; Maulood et al. 1979; Al- Saadi and Antoine, 1982; Antoine 1983; Al- Asadi 1983). Little variation can be seen between the two stations. Several investigators have found that the Shatt al- Arab estuary is a well mixed ecosystem (Mohammed 1965; Hameed 1977). Other investigators have found that sewage input of Basrah city by one or two of the canals is slight and masked by the dilution and tidal effect (Antoine and Shihab 1977; Al- Saadi et al. 1979; Al- Saadi and Antoine 1981; Antoine and Al- Saadi 1982; Saad and Antoine 1983; Al- Asadi 1983).

Phytoplankton composition

A total of sixty- seven taxa were identified in both stations (Table 3). The number of taxa in station I (58) is higher than that of station II (52). The species diversity indices at the stations studied determined by Shannon's formula as described by Wetzel (1983) showed that the species diversity at station I (2.88) is also higher than the species diversity at station II (2.58). Much higher numbers of phytoplankton taxa were recorded in the stations upstream of Basrah city (Saad and kell 1975; Pankow et al. 1979; Maulood et al. 1981; Al- Saadi et al. 1981; Al- Zubaidy, 1985).

Table 2. Ecological conditions of the Shatt al- Arab estuary at stations studied (Values are mean of seven replicates)

	Station			
	Mean	95% condfidence	Mean	95% confidence
Temperature (^{0}C)				
air	12.23	9.39- 15.07	12.56	10.04- 15.08
Water	12.14	11.89- 12.39	12.24	12.05- 12.43
Secchi dise readings (cm)	79.29	73.67- 84.91	85.14	79.01- 91.27
pH*		7.87- 8.29		8. 10. 8.23
salinity (‰)	1.51	1.48- 1.54	1.51	1.49- 1.53
Dissolved oxygen (mgl^{-1})	9.59	9.43- 9.75	9.55	9.43- 9.67
Percent O_2 saturation (%)	89.31	87.70- 90.92	89.07	87.93- 90.21
Total available Co_2 (mgl^{-1})	220.74	216.27- 225.21	220.73	214.34- 227.12
No_2-N ugat l^{-1}	0.11	0.091- 0.13	0.11	0.082-0.14
NO_3- N ugat l^{-1}	6.53	5.96- 7.10	6.67	6.29- 7.05
PO_4- P ugat l^{-1}	0.32	0.26- 0.39	0.49	0.34- 0.64-
Sio_3- Si ugat l^{-1}	92.45	87.17- 97.73	92.26	87.86- 96.66

* Range of seven replicates, no mean was calculated because the values are log data.

Table 3. Phytoplankton taxa identified in the Shatt al- Arab estuary up and downstream of Basrah City center with their saprobic indecies. (a = ∝- mesosaprobic, b = ß-mesosaprobic, O = oligosaprobic. x = xer osaprobic, + = <100 cell ml^{-1} + + => 100 <500 cell ml^{-1}, + + + => 500 <1000 cell ml^{-1}, - = not recorded).

Taxa	Station 1	Station 11	Saprobic index
Cyanophyta			
Anabaena sp.	+	+	
Oscillatoria sp	+	+	b
Spirulina platensis	+	+ +	
Chrysophyta			
Bacillariophyceae (Centrales)			
Chaetoceros sp.	+	+ +	
Coscinodiscus sp.	+	+	x- b
Cyclotella meneghiniana	+	+ +	b- a
C. striata	+	+	
Cyclotella sp.	+	+ +	
Melosira italica	+ +	+	O-b
Stepanodiscus sp.	+	+	
Thalassiosira fluviatilis	+	+	
Bacillariophyceae (Pennales)			
Achnanthes lanceolata var. rostata	+ +	+	x- b
A. minutissima	+ +	+ + +	O- b
Amphipleura pellucida	+	+ +	
Amphiprora alata	+	+	b

Amphora sp.	+	+	x- o
Anomoeoneis exilis		+	x- a
Bacillaria paradoxa	+	+ +	b
Cocconeis placentula var. euglypta	+	+ +	b
Cylindrotheca gracilis	+	+ +	
Cymatopleura solea	+	-	b- a
Cymbella affinis	+	+	o- b
C. microcephala	+ +	+ +	
C. turgida	+	+	
Denticula rainierensis	+	-	
Diatoma tenue var. elongatum	+ +	-	
Diploneis ovalis var. oblongella	-	+	b
Epithemia zebra	+	-	o- b
Fragilaria pinnata	+	-	
Fragilaria sp.	+ +	+ +	
Gomphonema gracile	-	+	
Gomphonema sp.	+	-	
Navicula buccela	+	-	
N. cincta	+	-	b- a
N. cuspidata	-	+ +	b- a
N. inflata	-	+	
N. punctata var. coarctata	+	-	
N. pygmaea	-	+ +	a
N. radiosa	+	+	o- b
N. radiosa var. tenella	+	-	x- o
N. spicula	+	+	b- a
N. viridula var. rostellata	+	-	
Navicula sp.	+ +	+ + +	
Nitzschia acicularis	+ +	+ +	a

N. amphibia	+ +	-	
N. apiculata	+	+ +	a
N. closterium	+	+ +	
N. gracilis	-	+	
N. granulata	+	-	
N. hungarica	-	+	a
N. kuetzingiana	+ +	+	b
N. longissimia	+	+ +	
N. palea	-	+	
N. punctata var. coarctata	+ +	+	
Nitzschia sp.	+ + +	+ + +	
Pleurosigma delicatulum	+	+	
Surirella sp.	+ +	-	b
Synedra acus var. radians	+	+	b
S. fasciculata	+ +	+	
S. ulna	+	+	b
Synedra sp.	+ +	+ +	
Chlorophyta			
Chladophora glomerata	+	+ + +	b
Chlamydomonas sp.	+	+	
Scenedesmus quadricauda	+	+	b
Spirogyra sp.	+	+	c- a
Ulothrix sp.	+	+	c- b

However thirteen taxa were present in station II in number higher than in station I. This may be due to the input of the canals which are characterized by a high number of phytoplankton (Hameed 1977; Al- Saadi and Antoine 1981; Antoine and Al- Saadi 1982; Antoine 1983; Saad and Antoine 1983). The phytoplankton taxa of the two stations were dominated by diatoms. Similar results were found by others (Kell and Saad 1975; Huq et al. 1978; Al- Saadi et al. 1979; Al- Saadi and Antoine 1981). Attempt was made for the distribution and abundance of the taxa in the two stations according to the saprobic index. The indecies of Sladecek (1973) as cited by Hadi (1981) for freshwater algae and of Al- Saadi et al. (1979) were followed. five taxa belong to - mesosaprobic group; 11 ß-mesosaprobic group; the rest range between xenosaprobic and - mesosaprobic groups. Hameed (1977) reported 26 taxa of the phytoplankton in the Shatt al- Arab estuary as a ß- mesosaprobic indicators. In the present study 4 out of 5 taxa of - mesosaprobic group are present in station II in a number higher than their number in station I. Application of F- test as described by Elliot (1977) showed that the differences are highly significant (F = 9.39 at 0.01 level of probability). As was mentioned earlier this may be due to the effect of the sewage- input of Basrah city.

Enrichment study

Addition of selected nutrients to samples of water from any ecosystem and following the response of its phytoplankton community is one of the several approaches for the assessment of the growth- limiting nutrient (Goldman 1961; Healey 1973 and 1978). Unfortunately, no previous attempt was made for the assessment of the growth- limiting nutrients in the Shatt al- Arab

or any other Iraqi ecosystems. Almost all of the previous studies on the Shatt al- Arab were based on the water chemistry for the assessments of its trophic conditions (Antoine and Shihab 1977; Maulood et al. 1979; Al- Saadi and Antoine 1981; Al- Issa 1981; Antoine and Al- Saadi 1982; Antoine 1983). The data are highly variable (Talling 1980; Al-Asadi 1983). However, Hameed (1977) and Al- Saadi et al. (1979) have used the saprobic indices as indicators of the trophic condition of the Shatt al- Arab. They came to conclusion that the presence of phytoplankton taxa of high saprobic index in the Shatt al- Arab complicated its trophic condition. They have attributed the presence of these taxa to the effect of sewage- discharging canals of Basrah city. In the present study an attempt was made for the determination of the nutrients likely to be limiting for the growth of phytoplankton in the Shatt al- Arab. The results showed that severval taxa responded positively for the nutrients added (Table 4). However, the response was obvious for some taxa (e.g. **Cyclotella spp.**) in samples enriched with a combination of nitrogen and phosphorus. On the other hand, most of the taxa of the station I responded more than those of station II. This may indicate that nitrogen and phosphorus are likely to be the nutrients limiting the growth of phytoplankton in the Shatt al- Arab. It may also indicate that the phytoplankton in the Shatt al- Arab estuary upstream Basrah city suffer more than those of downstream. Further studies are required to clearify this point.

Table 4. Effect of addition of major nutrients on phytoplankton taxa of the Statt al-Arab up and downstream Basrah City Centre. (+ = <100 cell ml^{-1}, ++ = >100<500 cell ml^{-1}; +++ = >500<1000 cell ml^{-1}; ++++ = >1000 cell ml^{-1}).

Taxa	Inoculum		Control		Treatment									
					+N		+P		+N+P		+Si	
	Station		Station		Station		Station		Station		Station	
	I	II	I	II	I	II	I	II	I	II	I	II
Cyanophyta												
Oscillatoria sp.	+	+	+	+	++	++	+	+	++	+++	+	++
Spirulina platensis	+	++	+	++	+	+++	+	+	++	+++	+	++
Chrysophyta												
Bacillariophyceae (centrales)												
Chaetoceros sp.	+	++	+	++	+	++	++	+	+	++	+	++
Cyclotella meneghiniana	+	+++	+++	++++	++++	++++	++++	++++	+	++	+	++
Kuetz.												
C. Striata	+	+	+	+	+	++	+++	+	++++	++++	+++++	++
Cyclotella sp.	++	+++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++
Bacillariophyceae (Pennales)												
Achnanthes minutissima	++	+	++	++	+	+	+	+	+	+	+++	+
Denticula rainierensis Sov.	+	+	+	+	+	++	+++	+	++	+	+	+
Diatoma tenue var. elongatum	+	+	+++	+	+	+++	+++	++	++	++	++++	++
Fragilaria sp.	++	+	++	+	++++	+	++++	+	+	+	+	++
Navicula acicularis W. Sm.	+	+	+++	+	+	++	+++	+	++++	+++	++++	++
N. apiculata	+	+	+	+	+	++	++++	+	+++	+	+	+
N. hungarica	+	+	+	+	+	++	+	++	+	++	+	+
N. kuetzingiana Hisle	+	+	+	++	+	+	+	++	+	++	+	+
N. longissima (Breb) Ralfs	+	+	+	++	+	+	+++	+	++++	+	+	+
N. palea	+	+	+	+	+	++	+++	+	++++	+	+	++
N. punctata var coarctata	+	+	+	++	+	+	++	+	+	+++	+	+
Grun												
Navicula sp.	+	+	+	+	+	+	++	+	+	+	+	+
Nitzschia sp.	++	+++	++++	+++	+++	++	+	+++	+	++++	++++	+
Syndra acus var. radians	+	+	+++	+	+	++	+++	++	+	+++	++++	+
S. fasciculsta	+	+	+	+	+	++	++	+	++++	++	+++	++
S. ulna (Nitz.) Ehr.	+	+	++	+	+	++	++++	+	+++	+	+	++
Synedra sp.	+	+	+++	+++	+	+	+	+	+	+	+	+
Chlorophyta												
Cladophora glomerata	+	++	+	++	+	++++	+	+++	+	++++	+	+
Scenedesmus quadti ciauda	+	+	+	+	+	++	+	+	+	++	+	+

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Summary

Two stations were selected in the Shatt al- Arab estuary, up and downstream Basrah city centre. Seven water samples were collected from each station at selected tide levels. The number of phytoplankton taxa in the Shatt al- Arab was higher in the station upstream Basrah city centre compared with downstream station. The number of - mesosaprobic taxa showed a reverse pattern of distribution. The enrichment of water samples with the major nutrients indicates that the phytoplankton of the Shatt al- Arab is likely to suffer from the deficiency of nitrogen and phosphorus in upstream station morethan the downstream one.

« الملخص »

تمت دراسة مقارنة للهائمات النباتية في محطتين في مصب شط العرب اعلى واسفل مركز مدينة البصرة. جمعت سبع عينات من الماء من كل محطة في مستويات مختارة من المد. وجد ان عدد الهائمات النباتية في المحطة العليا اكثر من عددها في المحطة انسفلى وكذلك الحال بالنسبة الى تنوع الانواع في حين اظهر عدد الهائمات من مجموعة mesosaprobic - ∝ نتيجة معاكسة في التوزيع. وظهر من اغناء عينات الماء بالمغذيات الرئيسة ان الهائمات النباتية في شط العرب قد تعاني من نقص في النتروجين والفسفور في المحطة العليا اكثر منه في المحطة السفلى.